

# sPHENIX TPC software meeting

## 16<sup>th</sup> February 2017

Revisiting charge cloud formulation in TPC geometry

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# New formulation of charge cloud sigma

Ref :

how to improve the spatial resolution of the TPC

the ILC TPC:

$L \sim 2 \times 250 \text{ cm}$ ,  $\Phi \sim 300 \text{ cm}$

pads everywhere, size  $\sim 6 \times 2 \text{ mm}^2$

$N_{\text{pads}} \sim 1-2 \times 10^6$

$\sim 200-250$  pad rows

resolution per pad row  $\sim 100 \mu\text{m}$

point resolution for a pad:

$$\sigma_x^2 = \sigma_0^2 + D_t^2 \times l_d / n_{\text{eff}}$$

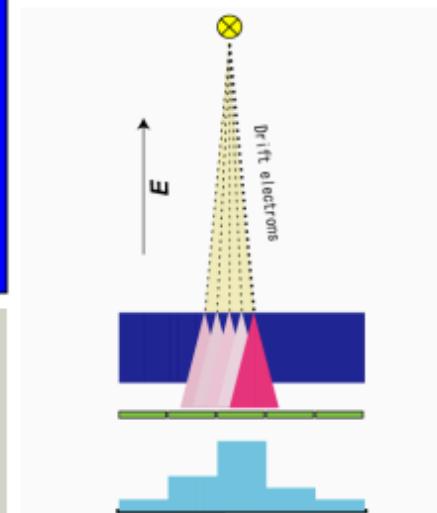
$\sigma_0$  = constant term

$l_d$  drift distance

$n_{\text{eff}}$   $\approx$  effective number of electrons

contributing to the signal  $\sim 20-30$  for 1cm

$D_t$  transverse diffusion coefficient in the gas,  
decreased by the magnetic field



- Formulation of cloud sigma in transverse direction changed.
- Now use the Ne2K gas parameters (diffusion coefficient in transverse , # of electrons liberated per cm due to gas ionization, drift velocity)

# Charge cloud sigma formulation and gas parameters

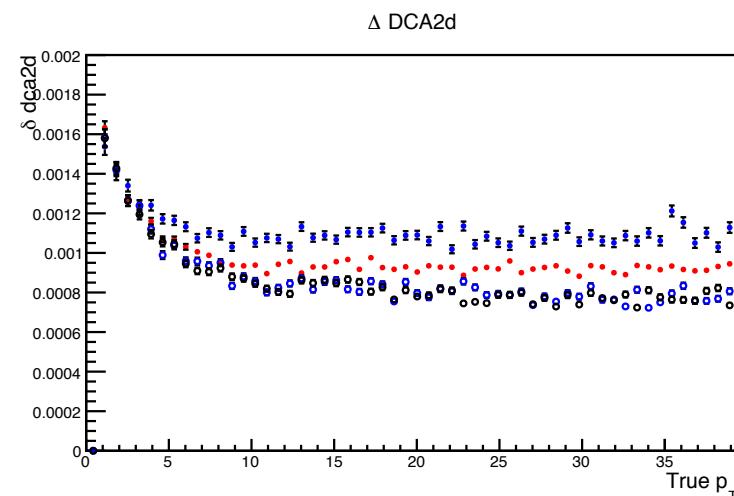
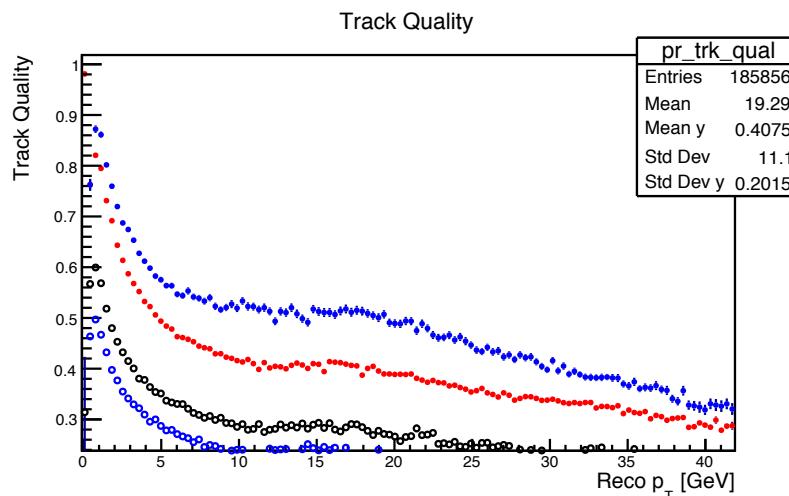
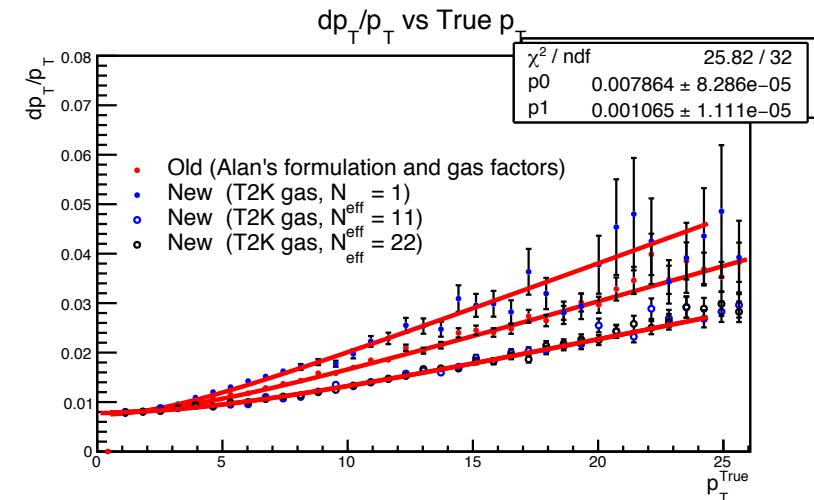
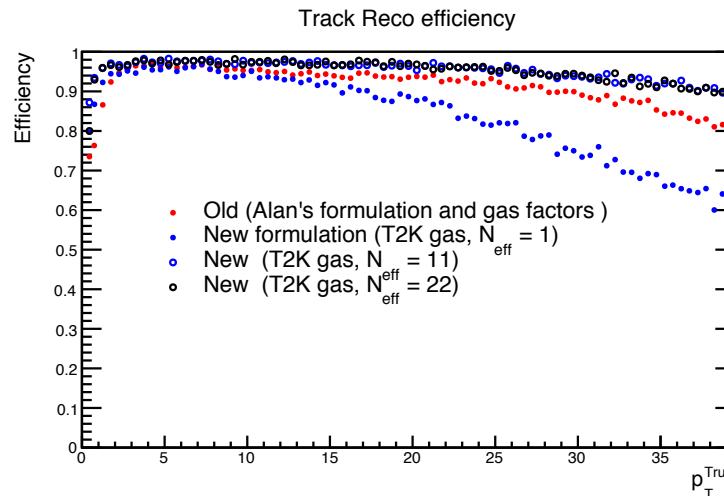
1. Old (Alan's) :  
sigmax =  $1.5 * \sqrt{(\text{diffusion} * \text{diffusion} * (\text{drift distance}) + 0.03 * 0.03)}$ ;  
sigmaz =  $1.5 * \sqrt{(1. + 2.2 * 2.2) * \text{diffusion} * \text{diffusion} * (\text{drift distance}) + 0.01 * 0.01)}$ ;  
where diffusion = 57 microns/sqrt(cm), #e- per KeV = 38 for both sigmax and sigmaz

2. New :  
sigmax =  $\sqrt{0.03 * 0.03 + (\text{diffusion} * \text{diffusion} * (\text{drift distance}) / N_{\text{eff}})}$ )  
where for Ne2K : diffusion = 135 um/sqrt(cm) , N\_eff = 1, #electrons per KeV = 28  
And for T2K : diffusion = 131 um/sqrt(cm) , N\_eff = 1, #electrons per KeV = 38

sigmaz =  $\sqrt{0.03 * 0.03 + (\text{diffusion} * \text{diffusion} * (\text{drift distance}) / N_{\text{eff}})}$ )  
where for Ne2K: diffusion = 178 um/sqrt(cm) and N\_eff = 1, #electrons per KeV = 28  
And for T2K : diffusion = 172 um/sqrt(cm) and N\_eff = 1, #electrons per KeV = 38

Here N\_eff : Effective number of electrons contributing to signal

# MAPS+TPC tracking quality with new charge cloud sigma formulation (N\_eff variation study)



- Detailed email exchanges between Mike, Jin, Klaus and myself during October 13-18, 2016 revealed that we are dealing with spatial extension of charge cloud and **NOT** the uncertainty of the position of measurement.
- No need to use N\_eff in the charge cloud sigma formulation and the revised expression is on next slide**

# Charge cloud sigma formulation and gas parameters

1. Old (Alan's) :  
 $\text{sigmax} = 1.5 * \sqrt(\text{diffusion} * \text{diffusion} * (\text{drift distance}) + 0.03 * 0.03)$ ;  
 $\text{sigmaz} = 1.5 * \sqrt((1. + 2.2 * 2.2) * \text{diffusion} * \text{diffusion} * (\text{drift distance}) + 0.01 * 0.01)$ ;  
where diffusion = 57 microns/sqrt(cm), #e- per KeV = 38 for both sigmax and sigmaz

2. New :  
 $\text{sigmax} = \sqrt(0.03 * 0.03 + (\text{diffusion} * \text{diffusion} * (\text{drift distance}))$  where for Ne2K : diffusion = 135 um/sqrt(cm) , #electrons per KeV = 28  
And for T2K : diffusion = 131 um/sqrt(cm) , #electrons per KeV = 38

$\text{sigmaz} = \sqrt(0.03 * 0.03 + (\text{diffusion} * \text{diffusion} * (\text{drift distance}))$   
where for Ne2K: diffusion = 178 um/sqrt(cm) , #electrons per KeV = 28  
And for T2K : diffusion = 172 um/sqrt(cm) , #electrons per KeV = 38